Case Study 76

Energy efficiency in sports and recreation buildings: swimming pool covers

Eastern Leisure Centre, Cardiff City Council

- Using a swimming pool cover every night saved over £9000 per year
- Saving represents 22% of sports centre's energy consumption, and 15% of its costs
- Payback on investment of 1.6 years
- Semi-automatic covers operable by two people
- Small-scale CHP, good housekeeping, BEMS and vigilant operation all contribute to good practice

Eastern Leisure Centre, Cardiff

Introduction

Public swimming pools are generally closed for at least 8 hours every night, but many maintain 24-hour/day heating and ventilation regimes that are appropriate to daytime occupancy. Eastern Leisure Centre in Cardiff has shown how use of a pool cover can allow major reductions in energy consumption when the building is closed, without adversely affecting bathing conditions.

A well-fitting pool cover provides an insulating, impermeable layer that greatly reduces heat loss from the water through convection and conduction, and virtually eliminates heat loss through evaporation. It therefore reduces the need for heating and ventilation. In certain circumstances, it can even allow a pool hall's heating and ventilation systems to be switched off altogether.

A high evaporation rate from the pool water necessitates high ventilation rates from the pool hall, in order to keep the relative humidity (RH) in the air space at an acceptable level (typically around 65% RH). The rate of evaporation from an uncovered pool depends on several factors, including:

- temperature difference between water and air
- humidity level of the air in the pool hall
- number of bathers, and length of time the pool is occupied
- surface area of the pool
- air movement over the water surface.

The humidity level of the pool hall air is very important. If ventilation is excessive, the air will be too dry, and high evaporation losses will occur. On the other hand, inadequate ventilation will lead to too high a RH, causing discomfort for pool users, and increasing the risk of condensation, mould growth and deterioration of the building structure. Hence there is a need to control ventilation in order to keep humidity levels within certain limits.

SPORTS COUNCIL

ISRM
The Institute of Sport & Recreation Management

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This Case Study has been developed with, and is endorsed by, the above organisations.

BEST PRACTICE PROGRAMME

ENERGY EFFICIENCY

"Regular use of a swimming pool cover cuts energy consumption by 22% and energy costs by 15%"

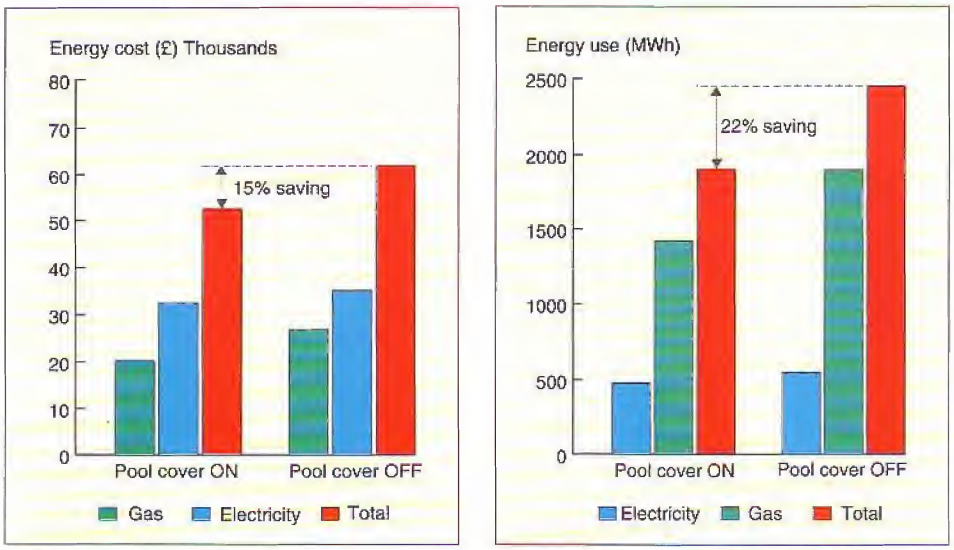

Figure 1 Eastern Leisure Centre annual energy consumption and costs, with and without a pool cover

Background

The Eastern Leisure Centre in Cardiff is owned by Cardiff City Council, and managed by an independent company under a CCT (compulsory competitive tender) contract. Built in 1982, it has a large sports hall and four squash courts as well as the swimming pool. Ancillary facilities include changing rooms, a secondary carpeted hall, a bar, snack bar and offices. The centre is open all year round, from 0730 to 2200 each day (0800 to 1730 on Sundays).

The swimming pool water temperature is maintained at 1 to 2°C above the pool hall air temperature.

The pool measures 25 m x 12.5 m, an area of 312.5 m^2, which is a little over 10% of the centre's total indoor area of about 3000 m^2.

The centre's space and water heating demand is provided by two gas-fired boilers and a constant load, gas-fired Combined Heat and Power (CHP) unit, rated at 55 kWe. The CHP unit operates as a lead boiler and provides the centre's heating and electrical baseload. The boilers provide additional heating as required.

The centre's ventilation system uses 100% fresh air. The cost of heating this air is reduced by air-to-air heat recovery units (heat exchangers) that are installed between the supply and extract ducts.

A Building Energy Management System (BEMS) helps to reduce energy consumption by controlling the setpoints, response and operating times of the main items of plant. It also allows easy monitoring of water and air temperatures throughout the centre.

As part of a good housekeeping programme, the centre has a policy of manually turning off lights in facilities that are not being used (such as squash courts), and turning off as much equipment as possible overnight.

The pool cover

The pool cover used at the centre is of the semi-automatic type and comprises a 5 mm thick laminated polyethylene foam sheet which extends across and floats upon the water, providing an insulating surface layer. Mounted on a motorised roller, it can be extended or retracted by two people within 5 minutes (one person operates the controls while the other guides the cover) – see figure 3.

After putting on the cover at night, pool staff allow a 15 to 30 minute delay before turning off all heating and ventilation to the pool hall and changing rooms (this enables any wet areas to dry out). Thus the pool cover is generally on for 8 hours overnight, while the heating and ventilation systems are off for about 7.5 hours.

Monitored energy and cost savings

At the Eastern Leisure Centre, using a swimming pool cover and switching off the pool hall's heating and ventilation systems for at least 7-hours every night is saving about 22% of the centre's annual energy consumption and 15% of its energy costs – for details, see box. This saving was worth £9340 in the 1992/93 financial year (1992 prices are used except where otherwise stated in this document). At that time, the quoted price for an equivalent semi-automatic cover was £14 690, fully installed, indicating a payback period on investment of about 1.6 years.

In 1992, the cover fabric and motor were replaced at a cost of £5100. The original system had lasted 10 years, with virtually no service or maintenance costs. During that ten-year period, after deducting initial installation costs, use of the cover saved the Council almost £80 000.

These savings are being achieved because, at this centre, it is feasible to switch off the pool hall heating and ventilation systems completely when the cover is in place. The only energy then used in the pool hall, before the cover is retracted next morning, is for pumps that circulate the pool water through a filtration system, to maintain water quality.

Results are widely applicable

Pool covers can be used cost-effectively in combination with a variety of plant operating procedures. Managers at Eastern Leisure Centre are fortunate in being able to switch off the heating and ventilation systems when the pool cover is in place. However, had they been able only to turn down the ventilation system at night – rather than switch it off – they could still have made substantial savings through use of the cover. To make the findings of this Case Study more widely applicable, projected energy costs and consumption figures are given for each of the four most typical combinations of operating possibilities, as shown in table 1. These are based on the following assumptions:

- electricity costs based on 1 hour at day rate and 6 hours at night rate for all nights except Sunday, where an additional 5.5 hours of gas and day rate electricity costs are added
- fuel costs are at 1992/93 rates, with overall costs of 1.39 p/kWh for gas, 7.22 p/kWh for electric day rate, and 2.81 p/kWh for electric night rate
- pool is used for 365 days a year, and average overnight internal to external air temperature difference is 20°C.

The figures in table 1 for electricity use show the effect of changing the ventilation rate from high through low to off (base electrical load is for the pool water circulation pump). The corresponding figures for gas consumption show how the ventilation heat loss can be progressively reduced.

Table 1 also shows how the savings obtained relate to the surface area of the pool (312.5 m^2). The normalised savings, shown in units/m^2, can be applied to similar-sized indoor pools to obtain an indication of the energy and cost savings possible from use of a pool cover. If the pool hall in question is well insulated and has heat recovery equipment, the savings thus predicted should be reasonably accurate. Greater savings are likely where pool halls are not well insulated.

Breakdown of energy and cost savings

For the year ending February 1993, during which the cover was used every night, the centre consumed 480 MWh of mains electricity costing £32 360, and 1420 MWh of gas costing £20 196. Electricity thus accounts for 25% of the energy used and 62% of the energy costs, whereas gas accounts for 75% of the energy used and 38% of the energy costs. See figure 1.

The calculated energy and cost savings, made possible by use of the pool cover and by switching off the pool hall's heating and ventilation systems, are shown in figure 1. This shows that the centre's annual gas and electricity consumption are reduced by 25% and 13% respectively, with a combined saving of 22% of total consumption.

In terms of energy costs, the savings are £6658 (25%) for gas, and £2682 (8%) for electricity. The total annual cost saving is £9340 or 15%. (The seemingly low reduction in electricity cost is because the centre is on a day/night electrical tariff, with night time electricity savings worth far less than day rate.)

Operating regimes				Annual energy saving		Total annual cost saving	Payback period
	Pool cover	Heating	Ventilation	Electricity kWh (kWh/m²)*	Gas kWh (kWh/m²)*	£ (£/m²)*	years
1	Off	On	High	—	—	—	—
2	Off	On	Low	40 000 (128)	104 000 (333)	2960 (9.47)	instant
3	On	On	Low	40 000 (128)	265 000 (848)	5190 (16.61)	2.8
4	On	Off	Off	71 000 (227)	479 000 (1533)	9340 (29.89)	1.6

*Savings per m² of pool surface area – indicative of possible savings for other pools.

Table 1 Overnight energy and cost savings at the Eastern Leisure Centre pool under different operating regimes

POOL AND HALL ENVIRONMENT

The monitoring exercise at Cardiff also showed the effect of the pool cover in each case on the overnight environmental conditions.

Relative humidity (RH)

Figure 2 shows the variation in overnight RH levels in the pool hall for each of the operating regimes. Note that levels are lower in all cases than those occurring during occupancy, and are all below 60% RH, which is an accepted value for pool halls.

The highest RH levels occur in regime 2, when no pool cover is used and the ventilation fans are on low speed. Increasing the fan speed to full (regime 1) only marginally improves this situation, but under regime 4, with cover on and both heating and ventilation off, the RH levels are far better (under 50% at virtually all times).

Many other factors will affect the economics of other situations, and these need to be examined individually. However, this Case Study provides a useful first indication of potential savings.

Maintaining adequate ventilation

When a swimming pool is closed, the use of a pool cover will greatly reduce heat loss from the water, and humidity levels in the air above. The need for heating and ventilation will therefore be reduced, and in some cases it will even be possible to temporarily switch off these systems altogether when the pool cover is on.

Energy savings would be pointless if the use of a pool cover encouraged changes to the heating/ventilation regimes that in any way caused discomfort to the pool users or were potentially damaging to the building. Of prime concern is the need to ensure that pool hall air and water conditions are pleasing to pool users, and that all relevant legal and health requirements are met.

If all the water surface cannot readily be covered, then heating and ventilation operation may be necessary at night to prevent an excessive rise in humidity. However, such operation can be minimised by simple RH (humidistat) control of the heating and ventilation systems.

If the level of fabric insulation of the pool hall building is poor, then covering the pool and switching off the heating and ventilation systems might cause the air temperature to fall below the dewpoint, allowing condensation to form on interior surfaces. In this event, again, the pool heating and ventilation will need to operate, but it may be possible to reduce the level of ventilation (eg regime 3 in table 1).

To avoid any risk of structural damage, professional advice should ALWAYS be sought to confirm the level at which heating and ventilation systems should be run in a swimming pool hall.

Air and water temperatures

Measurement showed that under regimes 1, 2 and 3 (both the heating and ventilation systems on), the overnight pool hall air temperatures were fairly steady, while under regime 4 (cover on, but no heating or ventilation) the temperature only fell by around 1°C on a cold night. Similarly, the pool water temperature remains within its setpoint limits overnight for all operating regimes.

In any situation where condensation is a possible concern, regime 3 (pool cover on overnight with the fans on low speed and the heating on) should be adopted to ensure a dry hall. The payback period is still below three years.

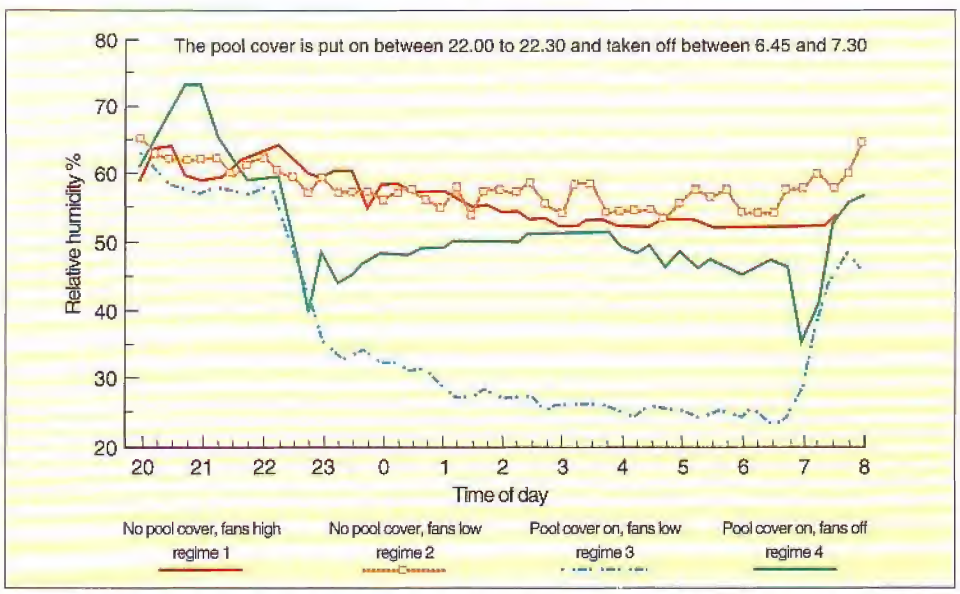

Figure 2 Effect of pool cover and ventilation regime on the overnight relative humidity (RH) in the Eastern Leisure Centre pool hall

Freeform pools

Pool covers have been used successfully on all types and shapes of pool. To be cost-effective it is not essential that all of the water is covered. The complex shapes of many freeform or leisure pools would make the cost of complete coverage prohibitive, but any major reduction in exposed surface area will significantly reduce the heating and ventilation requirements.

Owner experience

Cardiff City Council owns eight indoor public swimming pools. All are now managed by independent companies under compulsory competitive tender contracts, and all bar three (two freeform leisure pools and one rectangular pool) are fitted with covers.

The Council has 15 years experience with pool covers. During that time it has noted a marked reduction in the rate of deterioration of pool hall building fabric after the introduction of covers, and it has become totally convinced of the cost benefits, both in energy and maintenance terms.

Pool covers used in Cardiff have been found to have a lifespan ranging from 5 years to over 10 years, with the motorised covers lasting the longest. The useful life of the motors is about the same or slightly less than that of the cover fabric.

CHECKLIST FOR THE PURCHASE OF A POOL COVER

Despite its apparent simplicity, a pool cover requires some thought before its purchase and before a realistic payback period can be calculated. The major questions to be considered are as follows.

Where will the cover be stored when not in use?

The physical problems to be overcome when trying to site a pool cover (or covers for more complex pools) can add significantly to the installation costs.

Who will in practice ensure the cover is put in place every night and removed every morning?

By answering this question you can determine whether a manual, semi-automatic or fully automatic pool cover should be purchased. Consider whether staff can be persuaded of the importance of this task. If only one or two people are available to put on or remove the cover, for example, then the weight of a manual cover could be a major deterrent to choosing this type. A motorised system is far more acceptable to staff, and generally increases the pool cover fabric's life. As a cover can only produce savings when it is in place, ease of use is of critical importance. These considerations will often justify the initial extra cost of a motorised system (see figure 3).

How is the heating and ventilation system controlled at present?

The answer to this question will enable the savings to be calculated more accurately. If the existing system is single-speed, higher savings will result than with one which already has an automatic speed control.

Can the pool cover supplier provide the names of pools where similar covers have been installed for some time and which can be visited?

A pool cover is a major capital investment and it is essential that the supplier's claims for durability and ease of use are verified before purchase.

Safety aspects

Safety is a very important aspect to consider when choosing a pool cover.

There are many different types of pool covers, ranging from manually operated thin plastic and bubble PVC covers to fully automatic heavy duty covers with guide tracks. Each type has its own characteristics and advantages. **Suppliers' claims for their safety should be examined with respect to expected use at your centre.**

For example, the ability of a pool cover to support a person's weight, if they should accidentally fall on it, may be important. This is particularly true if unauthorised access to the pool cannot be effectively prevented.

Poorly fitting covers, that leave gaps around the edge of the pool, can also present a danger if someone accidentally falls into the pool with the cover in place, and becomes trapped. Consider whether access to the pool needs to be restricted when the covers are on.

Pool cover being extended at Eastern Leisure Centre

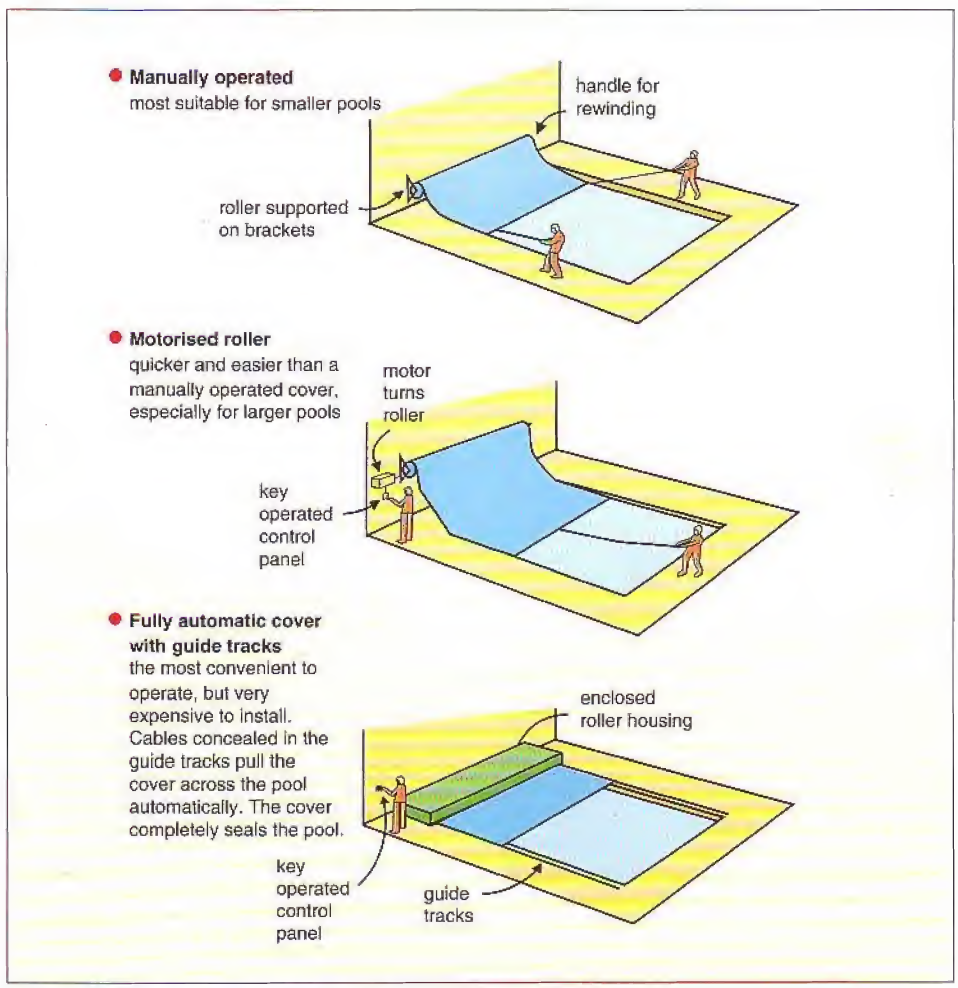

Figure 3 Alternative ways of operating a pool cover

Acknowledgements

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